

5 Forests and Climate Change

Forests and Climate Change Impacts on Forest and Rangeland Resource Sustainability

Scientists have generally agreed that the earth's climate is changing, in part due to human activities that alter the chemical composition of the atmosphere through the buildup of greenhouse gases. These gases—primarily carbon dioxide (CO₂), methane, and nitrous oxide (NO_x)—trap heat. Uncertainty exists about exactly how earth's climate responds to these gases and how much global temperatures will rise.

Forests play an important role in the earth's carbon cycle. On one hand, the loss of forests on a global scale to other uses (deforestation) is responsible for up to one-third of carbon emissions to the atmosphere and ranks second only to the burning of fossil fuels as a source of CO₂ emissions. On the other hand, forests serve as a large carbon sink. They capture CO₂ from the atmosphere through photosynthesis and store it as carbon in wood and other carbon-based compounds in soil, understory plants, and in litter on the forest floor. Large amounts of additional carbon are stored in U. S. forests, including those in California (Birdsey et al., 2000).

While older forests store the greatest total amount of carbon, by maintaining vigorous growth in all forests,

additional carbon can be removed from the atmosphere and stored in standing trees. Conversely, loss of forest lands, due to changing land use, and the soil and biomass that stores carbon can adversely affect and even contribute to greenhouse gas emissions.

Maintaining vigorous health of forests and conserving forest areas are vital to protecting resources from air borne pollutant impacts and provides opportunities for contribution towards pollution reduction through carbon sequestration. Objectives such as maintaining vigorous growth, increasing the volume of standing trees, retaining lands in a forested condition, and reducing wildfire all contribute towards carbon sequestration. Policies that promote conservation of forest lands and vigorous stands can significantly contribute to air pollution reduction. These same policies may also provide financial opportunities to landowners who are willing to manage their lands in ways that positively influence carbon storage.

Forests and Climate Change Indicators

- **Impacts of Climate Change on Forest and Rangeland Resources**
- **Effects of Forests on Carbon Levels**
- **Trends in Greenhouse Gas Emission Reduction**
- **Programs to Reduce Emissions of Greenhouse Gases**



Forests and Climate Change

Representative Goal

Acquire and develop data and information on global climate change for use in reducing or mitigating the production of greenhouse gases including net reductions through the management of natural forest reservoirs (*paraphrased from Cal. Public Resources Code Section 25730, Climate Change Inventory and Information*).

Findings

- Environmental and climate change impacts on forest ecosystems are likely to include the following: alteration in the growth and geographic range of different forest types; increases in the frequency of fire and insect outbreaks; and changes in the carbon storage function of forests (e.g., from sinks to sources).
- Multiple stresses (ozone, nitrogen deposition, land use change) and changes in human interactions with forests (e.g., settlement, recreational use) work in concert with climate change.
- California's forests and rangelands can provide a role in affecting global impacts from greenhouse gas emissions (primarily CO₂). Forests provide a large "sink" to sequester (capture) atmospheric CO₂ emitted from point and nonpoint pollution sources.
- Maintaining healthy forests will be vital to protecting resources from air borne waste impacts and provides opportunities to contribute to pollution reduction through carbon sequestration.
- Greenhouse gas (GHG) emission levels have risen by 3.5 percent in California between 1990 and 1999, compared to a U.S. rate of 11.5 percent. Carbon dioxide is the most common of these gases.
- California has a variety of programs in place to deal with climate change that involve forest and range resources. Examples include such programs as the California Energy Commission's Public Interest Energy Research Program; the State's Renewables Portfolio Standard; the Global Climate Action Registry, and a Joint Agency Climate Team to provide for agency coordination and program development. Taken together, these and other programs show an aggressive response by California policy makers to global climate change concerns.
- Additional State coordinated efforts are likely in such areas as GHG reduction; carbon sequestration and trading; research and development in renewable technologies; development of biofuels; increasing afforestation; land use policies that limit development on productive forestlands; and enhancing the State's capacity to project future climatic changes, assess impacts and evaluate solutions.

Impacts of Climate Change on Forest and Rangeland Resources

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter5_Forests_and_Climate/climate.html
Data Quality: Additional Development ?

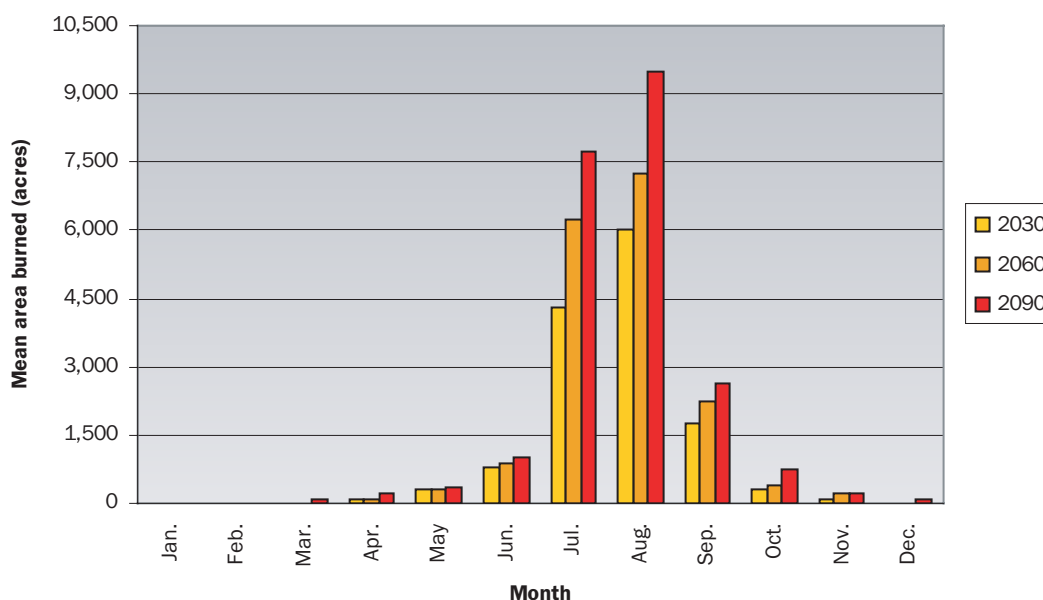
For California and other western states, scientists have been investigating the impact of environmental changes on forest ecosystems through field observation, controlled experiments, historical records, and computer-based modeling. They have identified the following areas of possible change:

- alteration in the growth and geographic range of different forest types;
- increases in the frequency of fire and insect outbreaks;
- changes in the carbon storage function of forests (e.g., from sinks to sources); and
- interactions of multiple stresses (ozone, nitrogen deposition, land use impacts, etc.) that work in concert with climate change.

Evaluations of these potential impacts of climate change are based on modeled scenarios and therefore contain significant uncertainties in quantification and relationship of variables. However, the basic premise is that climate change can alter both the function of forests and other natural processes.

One specific impact of climate change relative to forests and rangelands is the effect on wildfire. Fire behavior models predict a sharp increase in both ignitions and fire spread under warmer temperatures combined with lower humidity and drier fuels (Figure 71). The most severe effects will occur where modelled forecasts of vegetation change project an expansion of mixed conifer and a corresponding reduction in the red fir forest that occupies the next higher elevation zone. Mixed conifer types typically support more ignition prone fuels systems that also support faster spreading fires; the net result being an expected increase in both fire frequency and size.

Figure 71. Projected mean area burned in the Sierra Nevada bioregion, 2030, 2060 and 2090



Source: Wilkinson, 2002

Effects of Forests on Carbon Levels

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter5_Forests_and_Climate/climate.html
Data Quality: Partial 

Over the last decade, California's forests have been a net sink of carbon. On an average annual basis from 1987–1997, over 5.2 million tons of carbon were added to the carbon stock on forest land (Table 36). The largest increases in carbon stocks were in live biomass and wood products. The amount of carbon on the forest floor and in the soils decreased slightly, although this is likely the result of reclassification of forest types and lack of consistent age class information rather than a true loss of carbon.

Table 36. Annual change in carbon stocks on forest lands by accounting component, 1987–1997 (million metric tons of carbon)

Accounting component	Average annual change		
	1987-1992	1992-1997	1987-1997
Biomass	5.04	5.09	5.06
Forest floor and coarse woody debris	-1.42	-1.58	-1.5
Soils	-0.85	-0.83	-0.84
Wood products and landfills	3	2.03	2.51
Total	5.77	4.71	5.24

Source: California Energy Commission, 2002b

Trends in Greenhouse Gas Emission Reduction

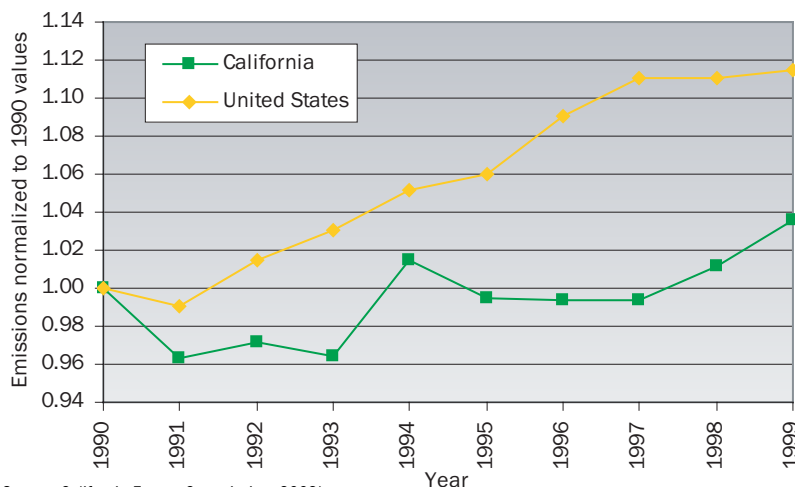
On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter5_Forests_and_Climate/climate.html
Data Quality: Partial 

California has seen a modest increase in greenhouse gas emissions over the last decade. Carbon dioxide (CO₂), is the most common emission representing 84 percent of all GHG emissions in 1999. This increase is the consequence of several divergent forces within California; some lead to increases in greenhouse gas emissions, while others negate those increases.

Forces that increase CO₂ levels include a growing population, high emissions from the transportation sector as a result of the State's position as the national leader in vehicle miles traveled, and low water years reducing levels of hydroelectric power as an alternative source to fossil fuel burning. Forces that decrease CO₂ levels include a relatively temperate climate, resulting in marginally less heating and cooling energy use than other states, and aggressive efficiency and environmental programs whose purpose is to reduce carbon dioxide emission rates (California Energy Commission, 2002b).

Figure 72 depicts overall trends in gross emissions in California and the United States as a whole. Gross emissions include emissions from all the in-state and United States sources normalized to 1990 levels to allow a comparison between emissions in California and the United States (i.e., gross emissions in each year are presented as a ratio of gross emissions in 1990).

Figure 72. Relative Gross Greenhouse Gas Emissions, California and United States, 1990–1999



Source: California Energy Commission, 2002b

Programs to Reduce Emissions of Greenhouse Gases

On-line Technical Report:
http://frap.cdf.ca.gov/assessment2003/Chapter5_Forests_and_Climate/climate.html

Data Quality: Partial ●

Aside from physical indicators of global climate change, another way of measuring how society is addressing an issue is the presence or absence of programs that focus on the issue. Ideally, such programs might follow a sequence, such as identification of possible impacts and risks of climate change; review of the ability of existing State programs to respond to extreme climatic events; development of approaches to reduce contributions to sources of climate change such as GHG; monitoring program results; and refinement of programs based on the results. While they might start simply, an evolving variety of programs would be expected since global climate change can have numerous interconnected impacts.

California has a variety of programs in place to deal with climate change that involve forest and range resources. Examples include the following programs:

- California Air Resource Board's air quality and GHG tailpipe reduction standards;
- California Energy Commission's (CEC) Greenhouse Gas Emissions Inventory;
- CEC Public Interest Energy Research Program;
- California Public Utilities Commission and CEC Renewables Portfolio Standard;
- Global Climate Action Registry; and
- Joint Agency Climate Team to provide for agency coordination and program development.

The California Air Resources Board (CARB) is mandated to set air quality standards. Standards are already in place dealing with ozone, fine particulate matter, and use of prescribed fire in forest management. In June 2002, legislation was signed into law granting authority to the California Air Resources Board to establish automobile tailpipe standards for GHGs.

The California Energy Commission is the lead State department under the California Resources Agency for evaluating and responding to global climate change issues since 1988. They have prepared several reports that detail the inventory of greenhouse gases emitted in California and policy strategies to deal with those emissions.

CEC also administers the Public Interest Energy Research (PIER) program. Established in 1997, it is an electricity-related research program that supports public interest energy research and development. Required to provide at least \$62.5 million per year through 2012 to conduct research, it is funded by a surcharge on electricity to electric customers of investor-owned utilities in California. PIER funding efforts are focused on several areas, including renewable energy. Forest and rangelands are the location of abundant and widely dispersed supplies of renewable energy resources, making renewable energy technologies excellent candidates for distributed energy generation. Examples are biomass, geothermal, and wind resources.

Another program is the Renewables Portfolio Standard (RPS) administered by the California Public Utilities Commission and the California Energy Commission. Under this program, retail sellers of electricity are required to increase their procurement of eligible renewable energy resources by at least 1 percent per year so that 20 percent of their retail sales are procured from eligible renewable energy resources by 2017. This will reduce reliance on burning of fossil fuels for generation of electricity, thus addressing a source of GHGs.

The Global Climate Action Registry was established in 2001. It is a non-profit voluntary registry for GHG emissions working in consultation with the State Air Resources Board. The purpose of the Registry is to help companies and organizations with operations in the state to establish GHG emissions baselines against which any future GHG emission reduction requirements may be applied. The Registry also can help participants obtain advice on how to use forest reservoirs as a mechanism to attain emissions reduction goals and the reporting of emissions results. In cooperation with the Resources Agency, the Registry is developing procedures and protocols for the monitoring, estimating, calculating, report-

ing, and certifying of carbon stores and carbon dioxide emissions resulting from the conservation and conservation-based management of forest reservoirs in California. Registry participants can include the results of those conservation activities as a participant's registered emissions results.

Commencing in 2001, a Joint Agency Climate Team (JACT) was formed to coordinate and integrate program activities related to climate change. Consisting of the California Resources Agency, Cal/EPA, State and Consumer Services Agency, Trade, Technology and Commerce Agency, the Department of Food and Agriculture, Department of Transportation, and the Governor's Office of Planning and Research, a number of proposed initiatives have been developed by JACT, including those that involve both the wildfire protection and forest management aspects.

Taken together, these and other programs show an aggressive response by California policy makers to global climate change concerns. Additional efforts are likely in such areas as GHG reduction, carbon sequestration and trading, research and development in renewable technologies, development of biofuels, increasing afforestation, land use policies that limit development on productive forestlands, and enhancing the State's capacity to project future climatic changes, assess impacts and evaluate solutions.